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Via Electronic Filing January 21, 2018

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth St., S.W
Washington, DC 20554

Re: **Comments for PSHSB Docket No. 17-344**
Public Safety and Homeland Security Bureau Seeks Comment On Response Efforts Undertaken During 2017 Hurricane Season

Dear Ms. Dortch:

Spectrum Financial Partners, LLC ("Spectrum Financial"), Pursuant to the Commission's Public Notice of Dec 7, 2017, hereby submits its comments in the captioned Proceeding[1]. As holders of 23 radio licenses, we at Spectrum Financial took great interest when Hurricane Harvey hit the Texas coastal regions, including counties for which we have license to provide mobile communications services. Our observations of Hurricane Harvey were expanded to include Irma, which helped to answer some nagging questions about mobile network operations. When Hurricane Maria hit, a wealth of lessons concerning civil preparedness engaged our curiosity to the point that good citizenship requires that we share our observations with the Commission and the public record. The author has previously been invited to present at earlier FCC Workshops[2], congressional staff briefings, and the preparation of

[1] Request for Comment DA 17-1180, in PSHSB Docket No. 17-344, available on line at: https://apps.fcc.gov/edocs_public/attachmatch/DA-17-1180A1.pdf, accessed Dec 18, 2017.

[2] FCC Workshop presentations such as LEARN Workshop 600 MHz Band Plan, May 3, 2013. Available on line at http://wireless.fcc.gov/incentiveauctions/learn-program/LEARNProgram0501013FINAL.pdf .
"FCC Band Plan Technical Forum" July 16, 2012 https://transition.fcc.gov/bureaus/oet/tac/tacdocs/meeting71612/PANEL2.2-Wilkus-Alcatel-Lucent.pdf and
Infrastructure Perspectives on Receivers, March 12, 2012 https://transition.fcc.gov/bureaus/oet/receiver-workshop1/Session3/SESSION-3-4-Wilkus-ALU.pdf.

whitepapers for 4G Americas and IWPC that suggests that these opinions are well considered.

We must first commend and thank the first responders and thousands of volunteers who came to the public's aid in preparations for and aftermath of the season's natural disasters. Their civic service and contributions have been and continue to be life-saving and an example we should all try to follow. In our case of telecommunications services, this includes the American Radio Relay League (ARRL); and the Radio Amateur Civil Emergency Service (RACES) and the 2017 Hurricane Tech Task Force of the Information Technology Disaster Resource Center (ITDRC) and surely many others. Our respects extend to those who redoubled their daily work to address their businesses service to their customers and communities, as well as government duties to the communities. This extends to Puerto Rico Telecommunications Regulatory Board (PRTRB), the staff of the FCC's Public Safety and Homeland Security Bureau, the Commissioners and many others.

The network operators and their field staff who have had to work excessive hours for many months, likely while their own homes and families are in need of attention, are due great respect and admiration. They have had to work in extremely difficult and dangerous and physically demanding environments. They have our great respect and appreciation.

Our respects and best wishes go out to all who have been harmed by these hurricanes either directly or indirectly.

Background of the Analysis

We have statistically analyzed the regularly reported status updates provided by the FCC's Disaster Information Reporting System (DIRS) combined with population and tower counts for all the counties tracked by the FCC this season. We have posted four commentaries on the subject on LinkedIn[3,4,5,6] and have provided tweets every day the FCC has provided DIRS reports.[7] The voluntary submission of DIRS data was negotiated through the good office of Representative Frank Pallone with the CTIA

[3] Recovery of the Cell Network damaged by Hurricane Harvey, Sept. 3, 2017 available on line at https://www.linkedin.com/in/stephen-wilkus-78000720/detail/recent-activity/posts/.
[4] Cellular Network Outage due to Hurricane Irma, Sept. 10, 2017, available on-line at https://www.linkedin.com/pulse/cellular-network-outage-due-hurricane-irma-stephen-wilkus/.
[5] Restoration of Cellular Networks in Puerto Rico and US Virgin Islands after Recent Hurricanes, Oct. 5, 2017 available at https://www.linkedin.com/pulse/slow-restoration-cellular-networks-puerto-rico-us-virgin-wilkus/.
[6] The 2017 Hurricane Season's Impact on Cell Networks, Oct. 12, 2017 available at https://www.linkedin.com/pulse/2017-hurricanes-impact-cell-networks-stephen-wilkus/.
[7] Tweets by username SAWilkus on the topic of #PuertoRico are available on-line at https://twitter.com/search?q=%23PuertoRico%20%40SAWilkus&src=typd.

founding the Wireless Network Resiliency Cooperative Framework and the top four wireless operators in the Continental US.[8,9]

The DIRS reports are based upon voluntarily submitted reports by impacted network operators, it is anonymized by the PSHS Bureau staff and aggregated on a county-by-county basis.[10] Unfortunately, this means that from day to day these reports may lack input from one operator or another and the consistency and perhaps the quality of the data may be variable. For example, we note that the total number of serving cell sites (the number of sites that are to be returned to service) varies suspiciously from day to day and appear to be assigned to different counties on occasion. For example, in the Dec. 11th report, the number of cell sites served in San Juan County dropped from 364 to 322 while Guayanilla County's jumped from 10 to 59 sites all while the total for Puerto Rico remained constant. The numbers returned back to their previous values the following day. The following plot shows how these numbers bounced around in the reports published by the PSHSB.

[8] Letter from Representative Frank Pallone, Jr. to FCC Chair Ajit Pai, Oct. 6, 2017 available online at https://apps.fcc.gov/edocs_public/attachmatch/DOC-347575A2.pdf.

[9] Improving the Resiliency of Mobile Wireless Communications Networks, PS Docket No 13-239 and 11-60, Order Released Dec. 20, 2016. Available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-173A1.pdf.

[10] The voluntary submission of DIRS data was negotiated through the good offices of Representative Frank Pallone with the CTIA founding the Wireless Network Resiliency Cooperative Framework and the top four wireless operators in the Continental US. https://apps.fcc.gov/edocs_public/attachmatch/DOC-347575A2.pdf.

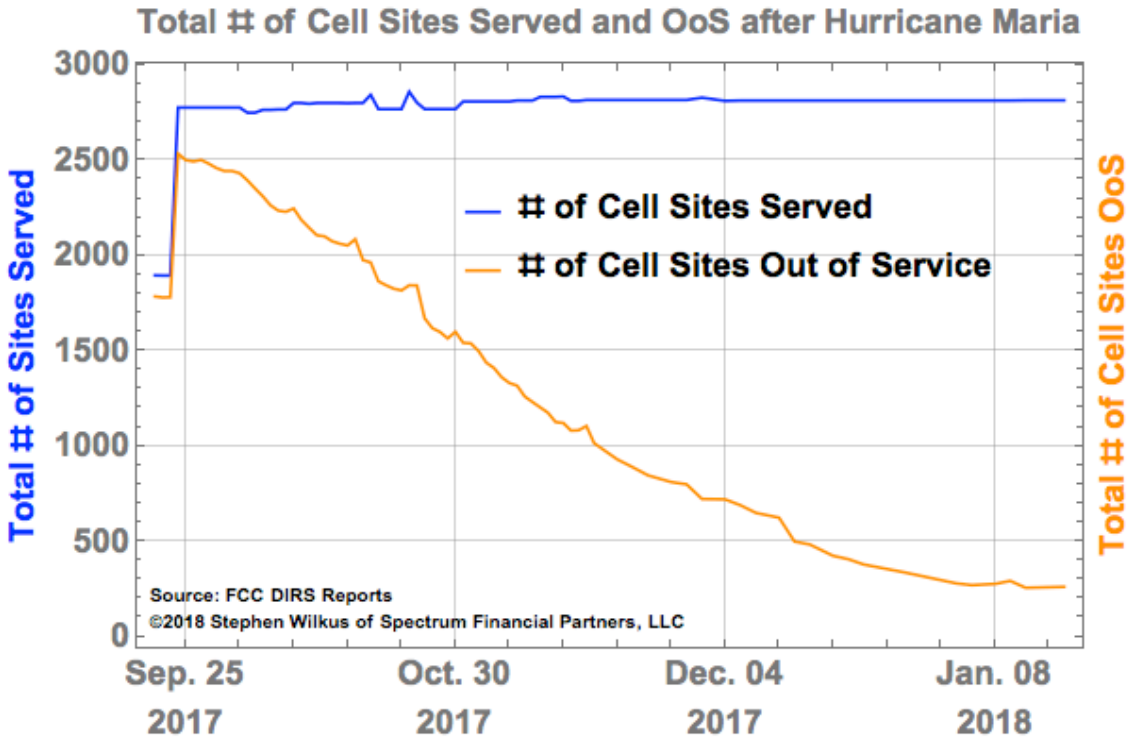


Figure 1 – The total number of cell sites served and the total number of cell Sites Out from the Hurricane Maria DIRS reports published by the FCC. Note how the total number of cell sites served has unaccountable jumps from day to day. There can be good reasons for this total to evolve during a recovery period, but the spikes that last a day are suspicious of bad reporting and accounting. The initial lower values for Sept. 21 to Sept 23 is may be due to a local mobile operator not submitting reports.

We see this in the detailed charts for specific counties of interest in the following chart as well. Here we see how the cell sites served appear to inexplicably jump from county to county even while the total remains unchanged. There can be good reasons for these "cell sites served" figures to evolve during the recovery period as operators plan to replace a some number of damaged sites with a different number of new sites. Old sites might have been chosen for outdated reasons as real estate or demographics and technologies such as air interfaces demanded while new sites may be more efficiently placed on newly built structures with more recent technologies to serve the latest population distributions, for example. So one can expect some changes in these counts. But seeing the numbers pop up and down again within three days is suspicious of bad record keeping. Unfortunately, calls and emails to the PSHSB asking for clarity have largely gone unanswered.

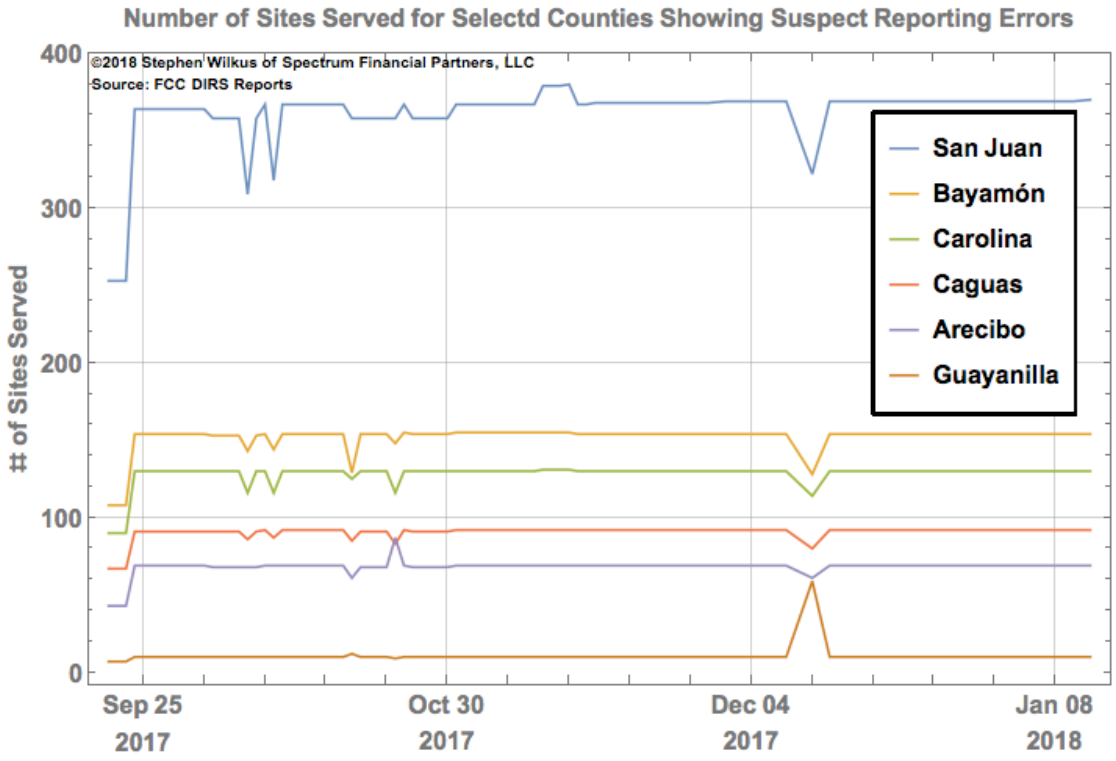


Figure 2 – Cell Sites Served for selected counties to show how these figures vary from one day's report to the next, sometimes even as the total remains unchanged. This raises suspicions about the quality of the reports --- perhaps understandably given the magnitude of the repair work underway. It is understandable for reporting and accounting to be a lower priority than the life-saving work of restoring communications.

We appreciate that during recovery from disasters paperwork takes a lower priority than the work the lifesaving work at hand. So we do not begrudge the staff these problems with the reports, but we point them out to give an appreciation of the task relative to other priorities.

The various reports by the operators are anonymized and aggregated so that only summary data for each effected county is published as shown for example, as shown below.[11]

[11] An example report available on-line at https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0117/DOC-348749A1.pdf . The collection of all reports is available at https://www.fcc.gov/maria.

Table 1 – Example Data from the DIRS report of January 17, 2018

Puerto Rico:

State	Affected Counties	Cell Sites Served	Cell Sites Out	Percent Out
PR	ADJUNTAS	10	2	20.0%
PR	AGUADA	18	0	0.0%
PR	AGUADILLA	48	1	2.1%
PR	AGUAS BUENAS	20	4	20.0%
PR	AIBONITO	21	1	4.8%
PR	ANASCO	15	1	6.7%
PR	ARECIBO	69	1	1.4%

-
-
-

Unfortunately, this aggregation of the data results in the public only seeing net changes per county. For example, there were 4 Cell Sites Out in Arecibo as previously reported on January 12 while we see just 1 on the report shown in Table 1, suggesting that there were 3 sites repaired in the intervening days. However, for all we know there could have been, say, 2 sites that dropped out of service while 5 were repaired and the same aggregate totals would still be accurate, however misleading.

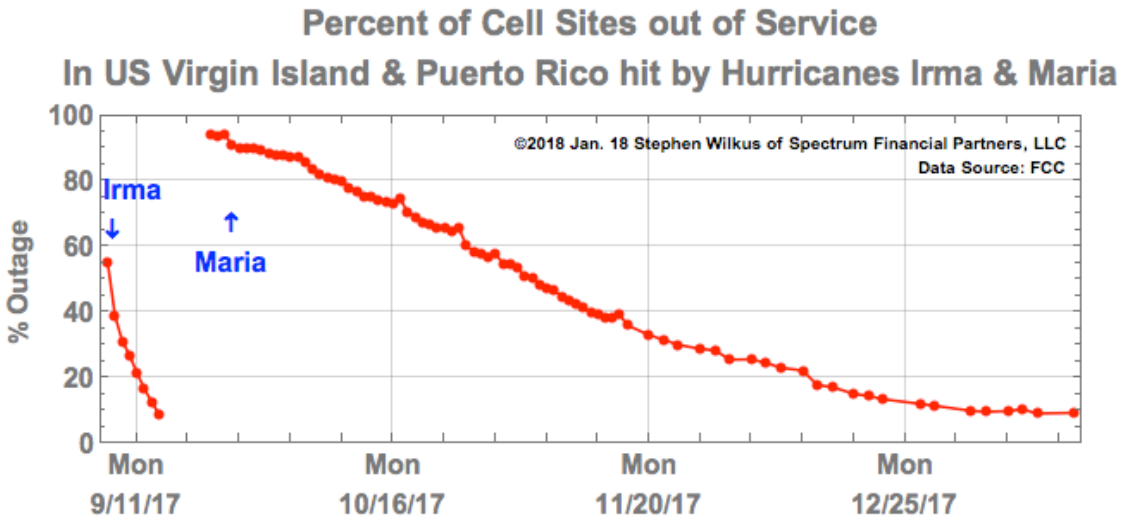
The observant reader will note the need to consider failures of cell sites that have previously been repaired. There have been 26 counties out of 81 that have had all cell sites operating at one time or another since Hurricane Maria, yet only 14 counties are currently operating at 100%. By examining the rate at which these fully functional counties have lost service since previously repaired, we learn that the median failure rate is about 0.87% ± 1.4% per day. This is a substantially higher failure rate for operating cell sites than we tend to see in healthy networks, but presumably there are many more additional failure modes in a disaster area due to things like utility pole replacement, road access for replenishing diesel fuel and temporary repairs that are later replaced.

The upshot of this is that these public reports allow us to observe that the average repair rate for Puerto Rico and the US Virgin Islands has been 20.6/day (averaged over the previous 120 days) but this is only the NET repair rate, we know that there were likely many previously repaired sites that failed those same days and as repairs progressed, the number of failures of repaired sites has increased. This results in a declining daily repair rate, as we see in Figure 3 below.

Figure 3 also makes an additional point very clear. The repair rate after Hurricane Irma peaked at 159 sites in a single day (Sept. 8 to 9, 2017), and averaged 91 repaired sites per day while repairs after Hurricane Maria has decreased from 29/day in the first month to 23.3/day averaged over the 118 days since landfall and has been averaging

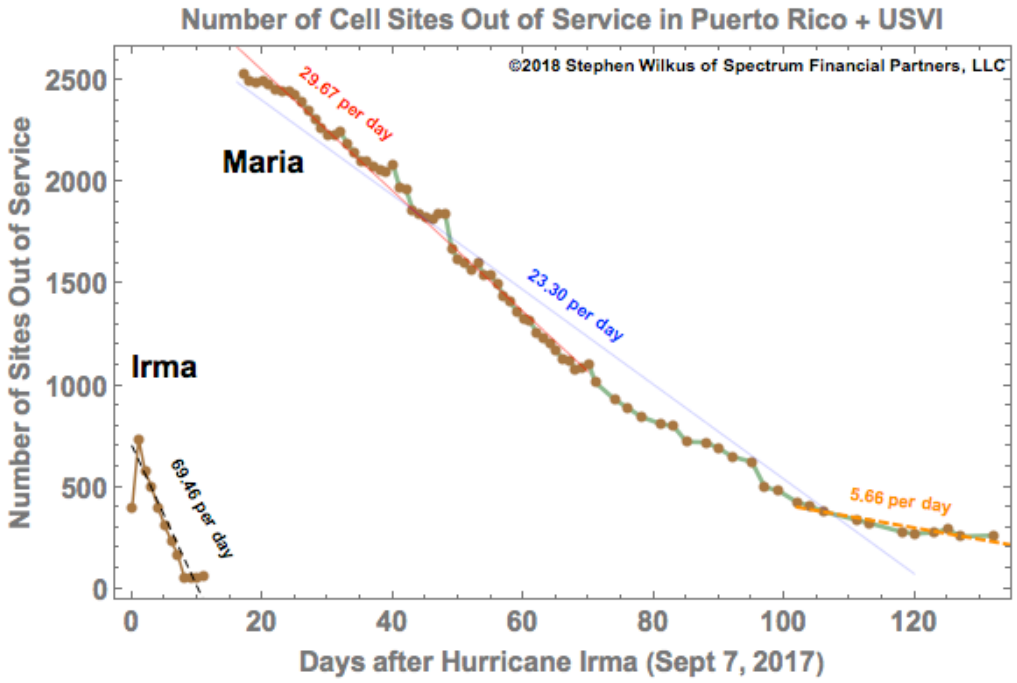
less than 6/day this past month. This clearly shows that the workforce and equipment in Puerto Rico and the USVI were very capable of handling the recovery from Hurricane Irma but were overwhelmed by Hurricane Maria. It was not a matter, as one politician has tweeted, "…Such poor leadership ability by the Mayor of San Juan, and others in Puerto Rico, who are not able to get their workers to help. They want everything to be done for them when it should be a community effort."[12]

We see here the clear difference between the response to Hurricane Irma and the immensely more devastating Hurricane Maria. We see that the fast repairs made after Irma are not repeated after Maria, surely not because of lack of dedication, but perhaps because of exhaustion of resources like diesel fuel, cleared roads and replacement equipment, all due to the immense destructive power of Hurricane Maria and the cumulative effect of so many powerful storms this season. Note that we've filtered out the cell site outages for the counties in the Continental US, which were 7 times fewer than the cell sites in the Caribbean region. It is no wonder than the response on the continent were more rapid and capable, they were minor compared with the Caribbean destruction, not to mention the greater ease of getting supplies and assistance delivered on the continent compared with the shipping difficulty to the islands. Port and Airport and road repairs were also needed to deliver shipments of supplies and additional personnel.



(a)

[12] Tweet of Sept. 30, 2017 available at https://twitter.com/realDonaldTrump/status/914089003745468417.



(b)

Figure 3 – The percentage of Cell Sites Served that are Cell Sites Out of Service in the US Virgin Islands plus Puerto Rico. Note how the restoration rate varies with time. The difference in restoration rates for Hurricane Irma and Maria is striking. (b) Shows the actual counts of cell sites out of service while (a) shows the percentage fraction of the reported cell sites served.

Analysis of DIRS report data

We have created an animated map illustrating the restoration of service in the aftermath of Hurricanes Irma and Maria available online at http://spectrumfinancialpartners.com/Hurricanesmovie.gif (best viewed with Preview or MediaPlayer with arrow keys used to step through frame by frame). We summarize the four Hurricanes by comparing the populations of the effected counties weighted by the fraction of cell sites out in each county as shown below in Figure 4.

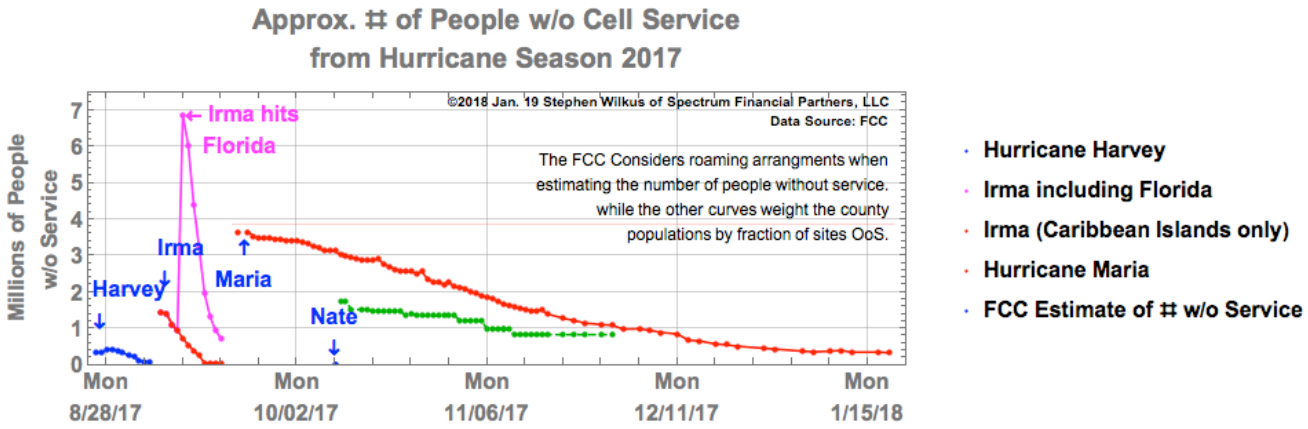


Figure 4 – Comparisons of the population impact on the cellular network outages of the 4 Hurricanes of the 2017 season. Note that the impact of Hurricane Irma is shown with and without the Continental US cellular outage to permit comparing the impacts of Irma and Maria just on the US territories in Puerto Rico and the US Virgin Islands.

The population impacted is estimated by summing the populations of all effected counties weighted by the fraction of cell sites that are out of service in each county. This impact would have been mitigated once free roaming among the operators was implemented (after about Oct 10, 2017) as shown in the operator's estimates in green.

We summary the comparison of the four Hurricanes in graphic and tables below.

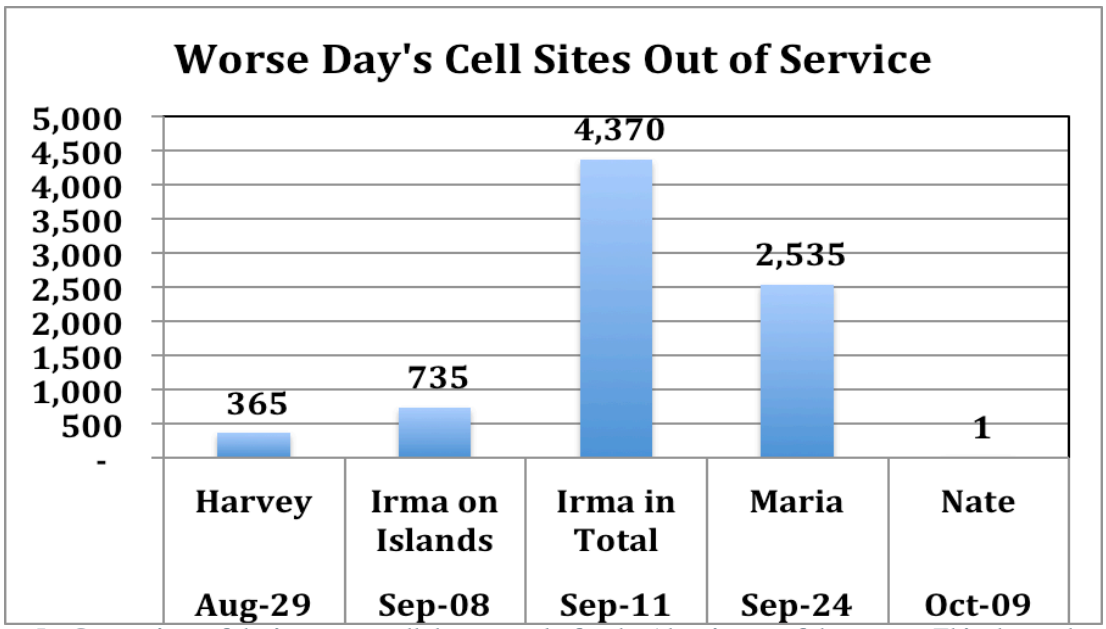


Figure 5 – Comparison of the impact on cellular networks for the 4 hurricanes of the season. This shows the worst day total number of cell sites out of service, it does not capture the total number of different sites that were rendered out of service over the multiple days. For example, by Sept. 11th, over 338 of the 735 cell sites on Puerto Rico had been repaired just as Hurricane Irma hit Florida.

In this summary table below we see the substantial variation in repair rates and the numbers of people affected by the Hurricanes. We've broken out the separate impact of Irma in Puerto Rico plus the US Virgin Islands and the continental US, so we can see

how the repair rates and populations differ. We define the "service impacted population" as the sum of counties weighted by the fraction of cell site outages per county, and the population of affected counties is the unweighted sum of populations of counties that had any cell site outage.

Table 2 – **2017 Hurricane Season Impacts on Wireless Services**

Hurricane	Worst Day for Service	Worse Day's Cell Sites Out of Service	Avg. Repair rate per Day	# of Affected Counties	Service Impacted Population (Millions)	Population of Affected Counties (Millions)	Percent of Population Affected
Harvey	Aug-29	365	42	44	0.428	11.287	4%
Irma on Islands	Sep-08	735	70	73	1.433	3.638	39%
Irma on Continent	Sep-11	3,973	496	77	6.146	19.773	31%
Irma in Total	Sep-11	4,370	484	150	6.873	23.411	29%
Maria	Sep-24	2,535	23	81	3.654	3.832	95%
Nate	Oct-09	1	1	1	0.001	0.415	0%

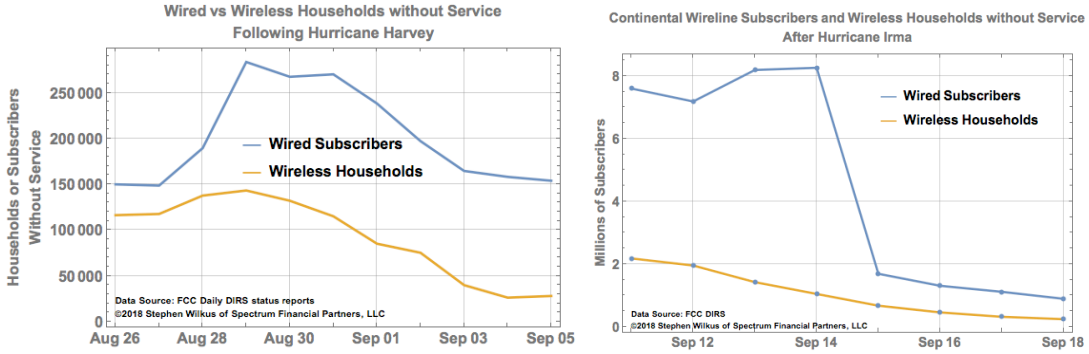
Lessons Learned

We use this data to consider some conventional wisdom and preconceived notions that can guide policy decisions and responses in the future.

1) Wireline vs Wireless Services – Plain Old Telephone Service (POTS) tended to work even after power outages. However, in the wake of a hurricane, wired phone service (either fiber or copper) may be cut by the same mechanisms as power mains are cut. In addition, increasingly wired phone services are deployed along with broadband services (so called "triple play"), which fail shortly after a power outage. We see this in this season's data as shown in the two graphics below where wireless households without service were a fraction of wired subscribership without service.

   The DIRS reports for Harvey and Irma included continental estimates of subscribers to wired phone service and the wireless services were aggregated by households per county weighted by the fraction of cell sites that were out of services in each county. For households with more than one wireless service provider, wireless would appear even more robust.

   Wireless service is further advantaged by the fact that the mobile units typically accompany the household members through evacuations and provide Wireless Emergency Alerts (WEAs) for notifying users of the current status/warnings.



(a) (b)

Figure 6 – Indication that wireless service is more robust after a Hurricane than modern wired phone services. The DIRS reports for Harvey and Irma included Continental estimates of subscribers to wired phone service and the wireless services were aggregated by households per county weighted by the fraction of cell sites that were out of services in each county.

2) Batteries and Power Generators – 47 CFR 12.2 requires 8 hours of battery backup for base stations and similar field equipment as a way of preserving service in the event of a line power outage. Indeed, this is an important and useful requirement for many typical storms. This author saw this benefit in the aftermath of Tropical Storm Sandy in 2012, when AT&T phone service continued through several hours into the afternoon after the passing of the storm, and enjoyed the continued service due to Verizon's use of local diesel power generation. However, even as the power lines were laying on the ground where they were properly shut off, the fiberoptic backhaul cables were still active and did not break as repair trucks drove over them.

   Some of this benefit may also have been useful in the aftermath of Hurricane Harvey and may have kept Hurricane Nate from taking down many more base stations, but in the aftermath of the highly destructive Hurricane Maria, towers were collapsed or roads and associated utility polls were washed down canyons, battery backup likely served little use as evidenced by the month needed to restore service to even half the cell sites.

   Perhaps diesel power generation along with diversity in the backhaul with both wired cable (either fiber or copper) along with microwave backhaul would have been helpful. Knowing that early restoration work including installing wireless backhaul and satellite backhaul, we look forward to reading accounts of others to learn what impact that might have had.

3) Loon Balloons – Alphabet (dba Loon Inc.) demonstrated remarkable civic dedication to aiding Puerto Rico offered the services of their Project Loon stratospheric balloon team to provide some restoration services after Hurricane Maria. The FCC and several operators rapidly coordinated waivers, and spectrum access along with ground interconnect facilities to enable the many

Loon balloons to provide emergency service from the experimental platform.[13] All parties to this effort deserve great commendation and respect.

Our understanding from conversations with people in Puerto Rico is that the system has indeed provided useful service.

However, we've also monitored the position of the balloons through FlightRadar24, an on-line service that tracks aircraft including these balloons using beacons on board the aircraft. We see for example, recent tracks of the balloons over near the island as of Sunday Jan 21, 2018 as shown below with red trails showing the day's recent movements.

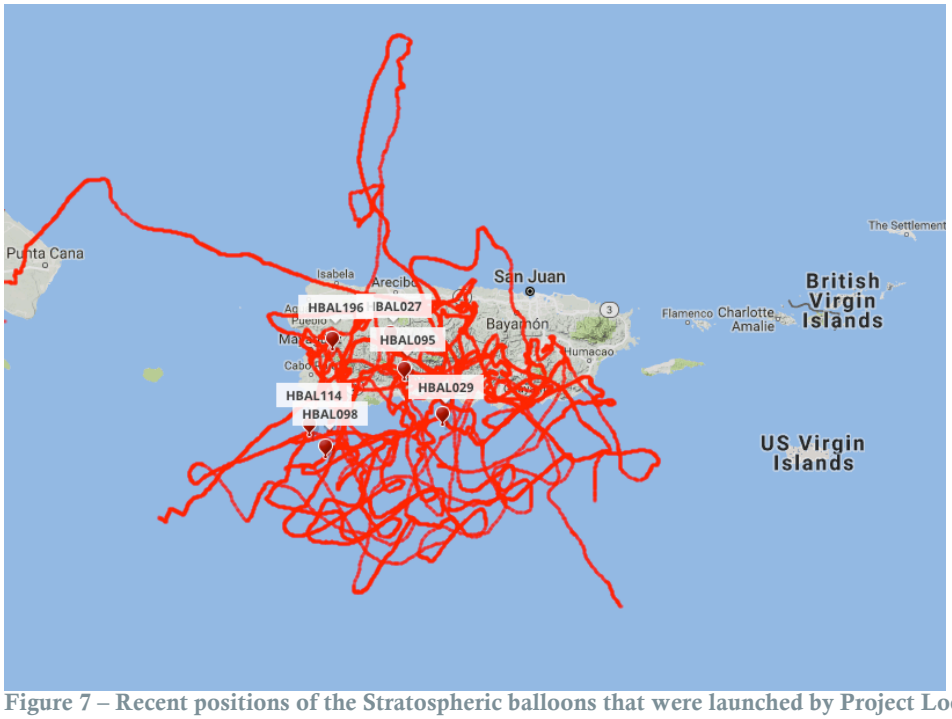


Figure 7 – Recent positions of the Stratospheric balloons that were launched by Project Loon, Jan 22, 2018.

It is possible that not all of the Loon balloons are continuously tracked by https://www.flightradar24.com, but most of the data appears valid and complete. We see in the figure above that the South Western part of the main island of Puerto Rico is provided some service this day. However, we also see a great deal of movement and difficulty with "station-keeping." We've captured 46 snapshots of the position of these balloons spanning 70 days and we see that in 16 of these snapshots (typically taken in the late afternoon or early evening) that the balloons have been "out to sea" and beyond expected communication

[13] Special Temporary Authority (STA) Experimental license from Oct. 6, 2017 to April 4, 2018 with two 5 MHz LTE carriers, Call sign WL9XWQ, available on-line at https://apps.fcc.gov/oetcf/els/reports/STA_Print.cfm?mode=initial&application_seq=80734 with application exhibit to File No. 1498EXST2017 at https://apps.fcc.gov/els/GetAtt.html?id=199448&x=.

range, 35% unavailable). Moreover, only in one case was the entire main island within range of the balloons (on Nov. 24).

The probability of coverage is suggested by the following map with the coverage areas of the various balloons showing a probability density through overlapping snapshots. Each snapshot is available for inspection as a gif movie at http://spectrumfinancialpartners.com/LoonBalloons.gif The viewer will see several snapshots in which no Loon balloons are visible in the frame, an indication of the difficulty in station-keeping, as shown in Figure 8.

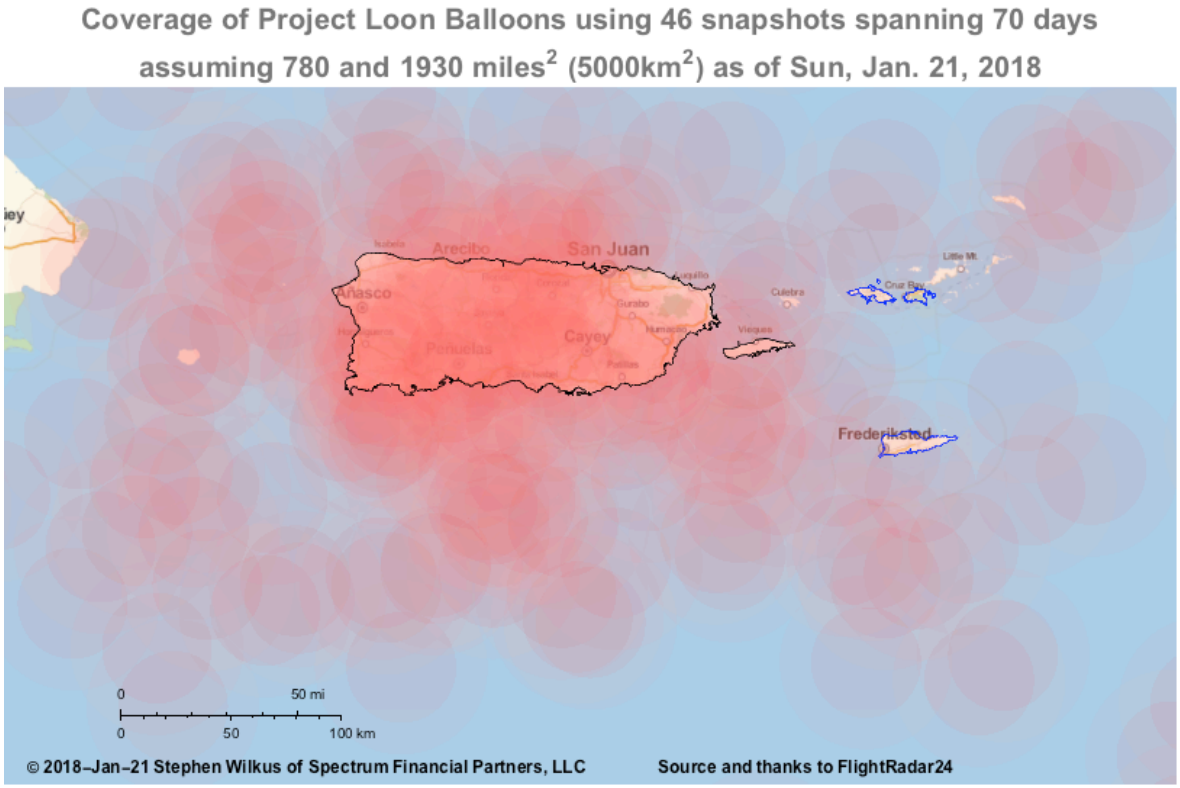


Figure 8 – Probability of coverage map of Project Loon balloons, formed by overlapping 46 snapshots taken from Oct. 25, 2017 through Jan 21, 2018.

Our observation is that for a particular location on the main island there is a 23% to 40% chance of having connectivity to a Loon balloon at any given time. This is helpful but not robust or resilient. This poor ability to keep balloons in position may be a particular problem of island targets as trade winds tend to blow in predominant directions while more continental locations or near mountain ranges may be more appropriate where the balloons might tend to dwell against a mountain range, for example.

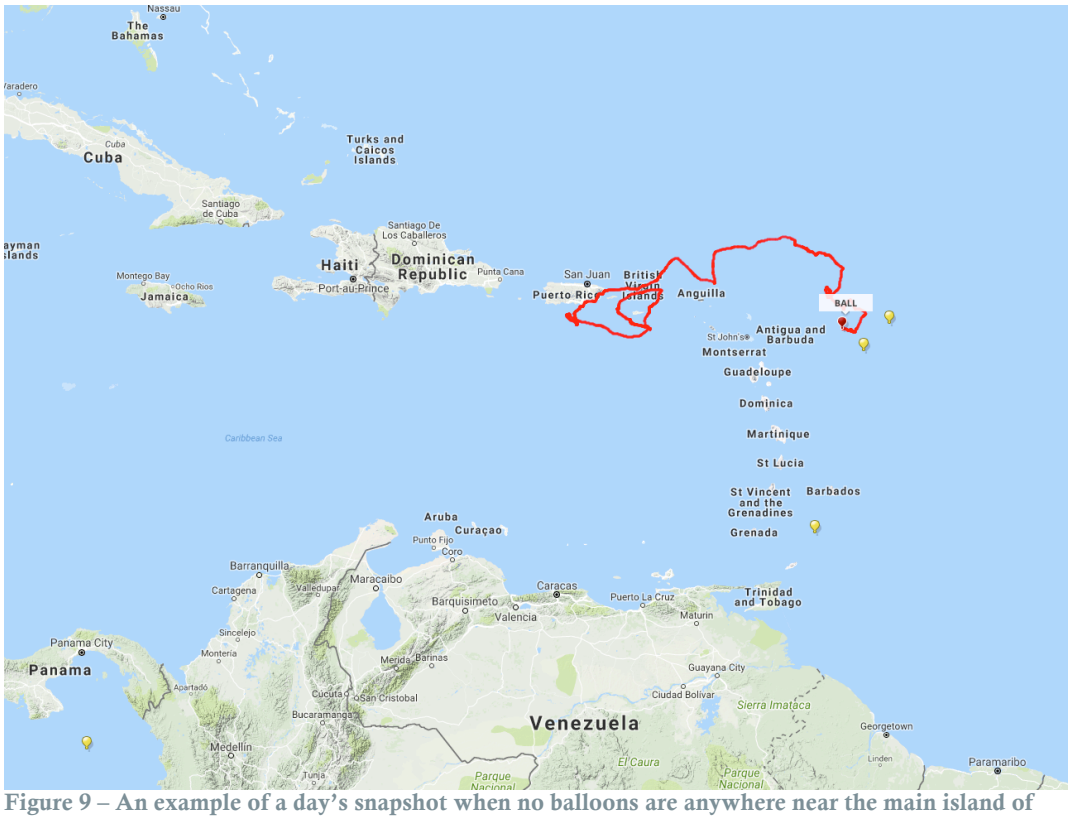


Figure 9 – An example of a day's snapshot when no balloons are anywhere near the main island of Puerto Rico. (Note the 4 yellow balloon icons and the one red one with its track shown.)

Simply adding more balloons that drift like a train over a target area might also offset this difficulty. The author looks forward to reading reports from Loon Inc, and associated companies one their lessons learned and what they may do to improve the robustness of the service in future disaster areas. But from this author's perspective, the approach is not able to provide robust service.

Alternatively, there are proposals for High Altitude propeller equipped platforms that the FCC and industry groups should consider for emergency service restoration. See, for example, the Thales Stratobus.[14,15]

Roaming Arrangements – A remarkable and civic outcome of the Wireless Network Resiliency Cooperative Framework is the agreement among operators to allow free roaming among the networks in disaster areas.[10] The advantage of

[14] What's Up with Stratobus? By Thales. Web site viewed Jan 20, 2018: https://www.thalesgroup.com/en/worldwide/space/news/whats-stratobus
Animated video at https://www.thalesgroup.com/en/worldwide/space/news/stratobus-halfway-between-drone-and-satellite

[15] Juan D. Deaton, "High Altitude Platforms for Disaster Recovery: Capabilities, Strategies, and Techniques for Emergency Telecommunications," EURASIP Journal on Wireless Communications and Networking Volume 2008, doi: 10.1155/2008/153469 available on line https://link.springer.com/content/pdf/10.1155/2008/153469.pdf

this roaming agreement is that a mobile user needn't be near one of his/her operator's repaired base stations, just that they be near any operating base station. Presumably this yielded a huge jump in connectivity. Presumably, it also allowed the field teams that were repairing broken base stations to coordinate plans to repair, say, the topmost antennas on a tower rather than repeated visits to the same tower to repair one operator's antennas or another's. Oddly, there was little sign of speedier repairs after Oct. 10, in fact, on Oct. 17 there was actually 32 more sites out of service than the day before (though on Oct. 10, there was a 60 site improvement in the number of sites in operation).

Based upon comments in the daily DIRS reports, this was triggered on about October 10, a full 20 days after Hurricane Maria made landfall. This appears to have been initiated very late in the game, and at a time when most mobile phones were unable to download the updated roaming list. These updates should be sent prior to an anticipated disaster of this sort, not 20 days after the event.

4) Diversity – The benefits of roaming among multiple operators discussed above can be extended conceptually to other modes of communications well. In particular, WiFi hotspots available in town centers and markets were no doubt effective work around to the decimated cellular systems. There are stories of Skype, Facetime and Whatsapp calls connecting families and friends and web access over WiFi hotspots to coordination centers and such that were godsends when they were available. Even HAM radio operators were important alternative way to communicate off the island. The FCC should continue to recognize the importance of diverse networks as critical to resiliency.

5) Broadcast radio embedded in mobile phones – There have been repeated calls for handset manufacturers and network operators to build-in and enable broadcast radio reception in handsets.[16] While intriguing, and potentially helpful, the quality of broadcast radio reception in a smartphone is limited by interference of the digital noise generated by the rest of a modern phone and by the limits to antenna design presented by the small form factor of modern smartphones. In particular, a smartphone utilizes the headset's wires as a poor substitute for a telescoping antenna and there is no room for the even longer wavelength AM antennas.

   It was also stunning to learn from the DIRS reports just how badly devastated were the broadcasting facilities on Puerto Rico and the US Virgin Islands after Hurricane Maria. Even then, it is worth noting that it took 25 days to see the number of FM radio stations rise from 8 to 26 (and later to 57) stations as shown below. Assuredly, Hurricane Maria is an extreme example of devastation to all communications, and the potential for FM reception in a smartphone can

[16] The Verge, "FCC chief wants smartphones' hidden FM radios turned on, but won't do anything about it," by Jacob Kastrenakes Feb 16, 2017 available online at https://www.theverge.com/2017/2/16/14636508/ajit-pai-smartphone-fm-radio-activation

indeed be useful. But after Tropical Storm Sandy, this author would commonly charge cell phones and laptops with a car charger while listening to broadcast radio in the car. Several battery operated shortwave and AM/FM portable radios were available too, but frankly, rarely used.

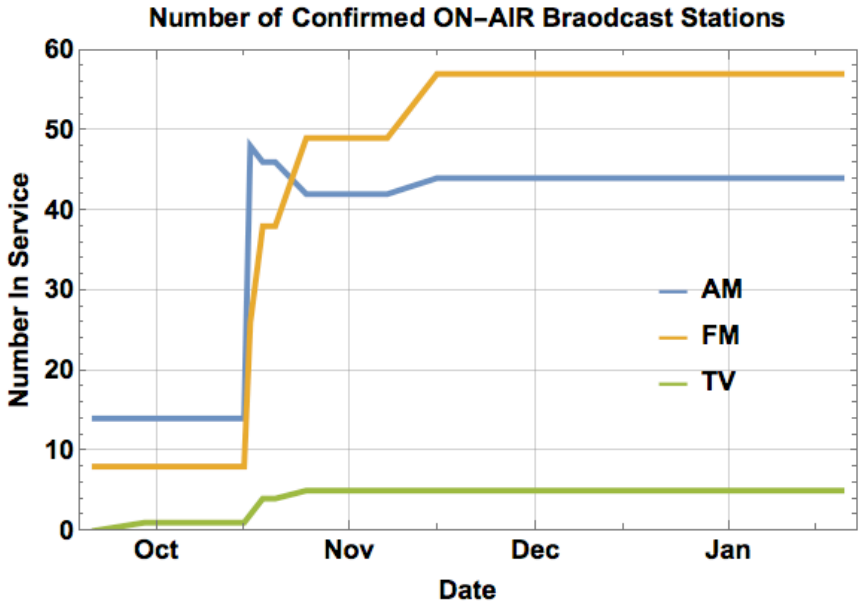
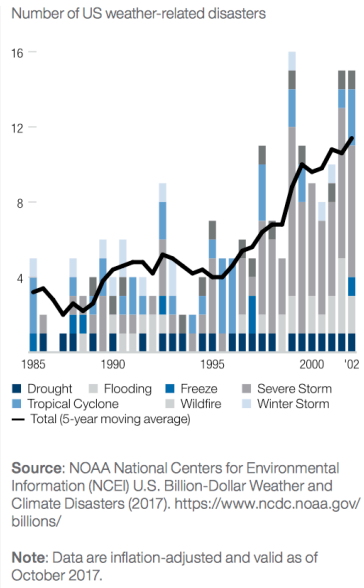


Figure 10 – The number of confirmed broadcast stations operating in Puerto Rico + US Virgin Islands after Hurricane Maria.



Proposals for Consideration

The World Economic Forum's Global Risks Report for 2018 identifies "Extreme weather events" as the most likely and second most impactful global risk in the coming years, just as it did in the prior year.[17] (The slightly more impactful event would be the use of weapons of mass destruction, though that is judged to be less likely.) The report points out that, "According to the Accumulated Cyclone Energy (ACE) index, which is used to measure the intensity and duration of Atlantic storms, September 2017 was the most intense month on record. It was also the most expensive hurricane season ever. These extreme incidents continue a trend towards increasingly costly weather events over recent decades…<as shown in the chart at right>"

These trends in the numbers and impacts of weather related disasters arise from many sources including the location of assets and population trends, but they are, thankfully, mitigated by decreases in the number of deaths due to natural disasters, as seen in Figure 11 below. The sort of planning and preparations done by the FCC and scores of

[17] The Global Risks Report 2018, 13th edition, World Economic Forum, ISBN: 978-1-944835-15-6. Available online at http://www3.weforum.org/docs/WEF_GRR18_Report.pdf

other agencies in the US and thousands of agencies and NGOs globally, and the life-saving aid by first responders and volunteers, have made immense progress in reducing the misery wrought by natural disasters. This past success should encourage yet more effort as we are reminded of our effectiveness in making improvements.

With this in mind, we offer the following suggested recommendations to the commission. Through all of these discussions, the FCC ought to aim to empower those on the scene, volunteers and neighbors alike, to be have situational awareness, the tools to assess the situations at hand and the means of using a variety of communications tools to provide aid when and where they find themselves called upon to offer aid.

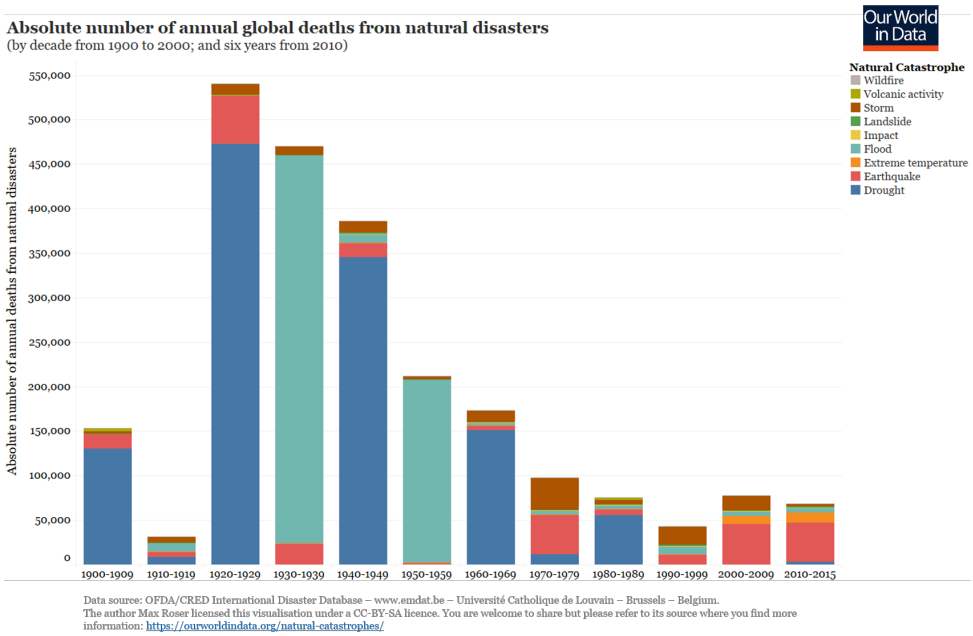


Figure 11 – Number of annual fatalities due to Natural disasters, globally. This improving trend in the fact of increased numbers and severity of natural disasters encourages us to redouble our efforts to address the misery caused by these events. Data from Our World in Data web site available online at https://ourworldindata.org/natural-catastrophes

1) Pre-deployments – The FCC and political leaders should encourage industry to take further efforts to pre-deploy people, resources and action plans prior to anticipated natural disasters. Hurricane Irma showed how Puerto Rico and the US Virgin islands had ample on-site resources to restore nearly 600 cell sites within a week, but these were evidently exhausted when Hurricane Maria made landfall a few days later. A number of operators have reported how they had barges and planes loaded with supplies in anticipation of Hurricane Maria, but blocked roads slowed delivery to the affected areas.

   One wonders, if by holding back the replacement of sites hurt by Irma, if there might have been more resources available for recovering from Hurricane Maria.

   If the framework agreement on roaming had been triggered prior to Hurricane Maria, the revised roaming tables could have been loaded into mobile phones while

the networks were still actively able to transmit them, and the phones were readily charged.

2) Metrics – The metrics collected and published in the DIRS status reports proved inadequate to the scale of a disaster the size of Hurricane Maria.

    a. Early reports obviously didn't include data from all the operators. For example, with Irma, there were a total of 1849 cell sites on the islands, after Maria the number jumped to 2777 and later rose to 2815, presumably as more operators provided accurate accounts of their sites.

    b. The number of sites served is a useful static number to understand who many sites were used prior to a disaster, but once sites are utterly destroyed as they were (water towers and monopoles leveled, for example), the desired number of new sites are appropriately reconsidered. New sites might be installed with more recent demographics and usage patters in mind, for example. So a better metric to compare against might be the total geographic area or population number served.

    c. The daily snapshot reports through DIRS does not capture the fraction of the day in which service might be systemically lost from power outages or central office switchovers, etc. Some indication of outages lasting more than, say, an hour, would be worth the Commission's notice.

    d. The network operators know how which of their customers have been connected to their core network, and even have good estimates of their locations. What fraction of subscribers are currently connected, and how many have been connected within the last few days and what numbers have connected through WiFi vs. cellular or roaming arrangements would provide a more appropriate measure of the citizen's experience of recovery.

    e. Broadcast statistics appear to mix full power stations with repeaters and translators so that the sum total of the stations is higher than expected. There are also a stunning number of "unconfirmed" stations (32 TV, 47 FM stations) after all these months. PSHSB should have confirmation by now.

3) HAPS – The leadership should consider incenting the mobile network operators to invest in a High Altitude Platform (HAPS) with shared network facilities to fly into a disaster area (HAPS fly mostly above the winds of Hurricanes) to provide quick assessment and restoration services, much as Loon Inc. has tried to provide service after Maria. But HAP platforms can have station keeping within a cubic km, and a lift capacity for much more capable power and bandwidth than antenna coverage than that of today's Loon balloons. Pre-positioning such platforms in anticipation of predicted extreme weather events would greatly reduce the difficulties for both first responders and citizenry.

Respectfully Submitted,
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